L HUSON & ASSOCIATES

REVIEW

NOISE IMPACT ASSESSMENT PREPARED BY AURECON
for
FLYERS CREEK WIND FARM

CLIENT:

FLYERS CREEK WIND TURBINE AWARENESS GROUP INC.

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EXECUTIVE SUMMARY

L Huson & Associates Pty Ltd has completed a preliminary review of the acoustic aspects of the Flyers Creek wind farm development proposal submitted by AURECON on behalf of Flyers Creek Wind Farm Pty Ltd in May 2011.

The review focuses on the sound emissions of the proposed wind turbines, the modelling used to predict sound levels in the community and the methods used to determine target noise compliance curves.

The documents detail background survey data that we believe is inaccurate and non-compliant with the requirements of the South Australian Wind Farm Noise Guidelines and the directions of the NSW DECC. There is insufficient detail to show what data was deemed to be removed from the analyses and no detail on the effects caused by the reported equipment failures.

The noise modelling described is at best unintentionally confusing. Incorrect parameters were input to the CONCAWE noise model and the results of this were used to justify the use of ISO9613 for the results presented to assess compliance.

Contradictory noise model accuracies are presented and the lower used to feign an approach of conservatism. Despite the vagaries of the noise predictions the results show non-compliance in idealised conditions for the wind farm for a number of dwellings.

The reports suggest that the wind farm should be built and then managed to reduce any non-compliant noise emissions. The management options include facilities available to the example wind turbine used in the study, which it is stated is not the preferred choice for the development. We believe that this approach is inappropriate and that for the project to be approved there should be a clear conservative margin of compliance in the assessment methodology and results.

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INTRODUCTION

L Huson & Associates Pty Ltd has been commissioned by Flyers Creek Wind Turbine Awareness Group Inc. to review the acoustic aspects of the Flyers Creek wind farm development proposal submitted by AURECON on behalf of Flyers Creek Wind Farm Pty Ltd in May 2011.

This review focuses on the sound emissions of the proposed wind turbines, the modelling used to predict sound levels in the community and the methods used to determine target noise compliance curves.

CHOICE OF WIND TURBINE

The turbines chosen for the study are the GE 2.5xl unit. This can have a hub height of between 75m and 100m and has a blade sweep diameter of 100m. The study says that this is a representative unit to use for the assessment at Flyers Hill. This turbine has a gearbox driving the generator in the nacelle. The GE website at www.ge-energy.com/products_and_services/products/wind_turbines/ states that the 2.5MW series has the "Best sound profile in its class while maintaining a high energy yield".

A simple observation is that this unit has been chosen to be representative of the type of unit being considered for the project, yet it has the 'Best sound profile in its class'. This begs the question of the unit being truly representative of the available turbines since it is apparently 'the best'.

COMMUNICATIONS FROM RELEVANT AUTHORITIES

The DECC has strongly recommended the use of the adopted Noise Assessment Guideline for Wind Energy Facilities (SA EPA 2003) but notes 'the incorporation of compliance assessment procedures in the draft 2008 version of these guidelines'. The letter from the DECC setting out their requirements is dated 8 January 2009, before the 2009 version update was released for the SA wind farm guideline. It would appear that the basis for the noise impact assessment should be the 2003 version of the SA Wind Farm guidelines.

BACKGROUND NOISE REPORT APPENDIX G1

The following comments are based upon interpreting the noise assessment in accordance with the SA 2003 Wind Farm Guidelines and the 2009 version. The Vipac background noise report dated 7 June 2010 has implemented the 2009 version for the measurements but has prepared the background noise trend curves using 10m AGL wind speed as required by the 2003 SA Wind Farm Guideline.

The SA wind Farm Guidelines 2003 and 2009 require determination of wind speed across each microphone used in the background study. This requirement is emphasised by DECC yet it appears that only two rainfall detectors and three wind speed and direction weather stations were used for the five monitoring sites. Obviously, the two background sites not having local wind speed measurements are non-compliant with the measurement requirements. Rainfall was only measured at two of the five background sites.

The Vipac report refers to wind screen manufacturers data, yet does not correct for wind speed at the microphone in accordance with the SA Wind Farm Guidelines, where manufacturer's data is used to correct the measured sound level. Rather, the simplistic approach of discarding data where the local wind speed exceeds 5m/s is used to remove invalid data (as provisioned in the guidelines when there is no manufacturer's data for the windscreens used). It is not clear from the reports if the 90th percentile wind speed was used to be the limit to discard noise data as required by the SA guideline. It would be acceptable to use an average wind speed as an alternative.

Rainfall at the two background monitoring sites (27 and 89) has been used to remove rain affected data at all 5 sites if those sites were within the locality of the rainfall meters. Rainfall can be localised so it would be better to have a rainfall meter at each monitoring site. Background sound level data at locations 12 and 25 have not been measured for local wind speed at the microphone in accordance with the guidelines or DECC directions.

It was noted that equipment failure occurred multiple times at locations 78 and 89, however, the total data excluded in table 5.1 of the Appendix G1 report lists only data removed due to rain or wind. There would be significant amounts of data removed due to equipment failure. For example, if the equipment at the end of a survey period will not calibrate successfully then one would suspect all of the data in that survey. Presumably, this would mean that only the last surveys at location 78 (4th to 17th December 2009) and location 89 (10th to 24th December 2009) would be valid. Appendix C of the background noise report does not show the continuous sound level data for location 78. All the data for location 89 is presented even though it is stated that there was equipment failures.

Background noise curves at four of the five background monitoring sites have been applied to other residences using an educated guess procedure. A better approach would be to apply the lowest noise curve obtained from the four monitored sites as a conservative measure for all other residences. Alternatively, take measurements at those residences.

The measurement location chosen for background surveys is loosely prescribed in the SA Wind Farm Guidelines. The only fixed requirement is that the monitoring location should be at least 5 m from any reflecting surface, other than the ground. In this regard, the measurement *locations* are compliant.

The regression analysis curve for location 89 is suspicious. The continuous noise data at this location shows the instrument noise floor to be approximately 30 dB(A) using the first instrument to 4 December 2009, then the noise floor reduces to below 20 dB(A), then the noise floor for the last instrument used from 10 December 2009 appears to be around 24 dB(A). The manufacturers of the ARL316 used in the latter part of the survey at location 89 and the first part of the survey at location 78 state the operating range (range over which sound level can be measured in compliance with the appropriate Australian Standard for sound level meters) is a minimum of 30 dB(A). Data below 30dB(A) using this type of equipment at location 89 and 79 will be suspect and outside the approved measurement range for the instrument. The use of this particular instrument has been criticised on other wind farm assessments over the past two years.

The SA wind farm guideline states that "The lower limit of the instrument measurement range must be chosen to provide accurate measurements which might be limited by the noise floor of the data acquisition device." Given that sound levels below 20 dB(A) have been recorded at location 89 using alternative instrumentation, the use of the ARL316 having a minimum certified measurement range to 30 dB(A) is inappropriate. The absence of wind data from 16 November 2009 to 25 November 2009 at location 89 is of concern since it is in this period that high sound levels occurred. The wind speed at the site measurement tower has exceeded 20m/s during this period, yet no wind data is recorded at location 89. We suspect that there has been a malfunction of the wind speed sensor during this time and that the sound levels reported are suspect. Data from this period has been included in the trend analysis. At the very least, background measurements for location 89 should be repeated with suitable instrumentation.

The trend analysis chosen is a third order polynomial, eg. $Y = x^3 + x^2 + x + C$. A third order polynomial gives two inflexions in the trend curve. The assessment of wind turbine sound power measurements ISO61400-11 stipulates the use of second order polynomial trend curves. The reason why the third order polynomial fits the data better than a second order polynomial is because there is marked clipping near the noise floors of the instruments used. A better approach would be to use integer bin wind speed averaging; however, this approach is not described in the SA Wind Farm Guidelines. We note that the SA guidelines (2009) state that the correlation coefficients are to be stated for each order from linear to third order. Only the third order has been provided in the background noise report.

The background noise report states that only one met mast was used to produce all of the noise trend curves. It would be more accurate to use met mast at turbine location 17 for background survey locations 12 and 78 and to use met mast data nearest turbine location 4 for background measurements at locations 25, 27 and 89. The objective of the background trend curve is to determine wind at the *nearest* wind turbines to the monitoring locations and to trend this data against background sound levels. The analysis should be repeated for measurement locations 25, 27 and 89 using data from the northernmost met mast.

General Electric has advised that they are working on a solution to a tone emitted from their 2.5xl wind turbine. Accordingly, this model will not, after all, be considered for this project and another turbine is likely to be used. Why did they not choose another representative turbine? Part of the impact assessment states that compliance can only be achieved at some dwellings if lower noise emission operating modes of the wind turbine, that is a feature of this particular model, are implemented. We question if any of the other alternatives have similar lower noise emission operating modes.

NOISE PREDICTIONS

APPENDIX G2 AND CHAPTER 12 MAIN REPORT

Noise predictions used the SoundPlan software suite. This software package includes a number of sound propagation models and some of these models, such as CONCAWE, have been altered within the software implementation. This is stated for distances closer than 200m in the SoundPlan literature but apart from this variation we can only *assume* that the SoundPlan implementation is true to the original. A comment on the variations from a noise model is required by the SA guidelines and none has been provided in the Vipac reports.

The noise models used have a suggested accuracy in Chapter 12 of +/- 2 dB(A). There are a number of properties that would exceed the suggested noise limits that were derived from the background sound surveys. Whilst we have detailed scepticism over the appropriateness of the background survey data it remains that the suggested compliance margins are often less than 2 dB(A). The report simply states that to address this issue the predicted sound levels will be increased by 2 dB(A) where the target noise levels are already 2 dB(A) or more higher than predicted. This has no material effect on compliance, however, if the accuracy of up to +/- 5dB(A) is used, as stated in the Vipac report section 6.2 of Appendix G2 Model Accuracy, then non-compliance would result.

For the situation where the suggested error margin of +/- 2 dB(A) is less than the margin between predicted and derived compliance levels then this situation could cause an exceedance of the SA Wind Farm Guidelines. However, the proponent asks us to believe that in these circumstances they will ensure compliance with the SA guidelines. This is a leap of faith and there has been no demonstration of compliance in the report. The assessment is certainly not conservative, especially since the Vipac report in Appendix G2 states that the accuracy of the noise model is worse than +/- 2dB(A).

Despite reference to CONCAWE in the reports, Vipac have used the ISO 9613 algorithm for all of the noise modelling results. The statement that 'The model was run for the worst case wind conditions for the range of wind speeds from 3m/s to 12m/s' is puzzling because the ISO 9613 algorithm does not include wind speed or direction. CONCAWE does include weather categories but ISO 9613 does not. The ISO 9613 standard is considered valid only up to wind speeds of about 3m/s. The discussion of the noise model in part 6 of Appendix G2 states that CONCAWE was used with only partially reflective ground factor (G=0.7) when the SA wind farm guideline stipulates that a ground factor of G=0 should be used. The atmospheric conditions stipulated in the SA guidelines to be used for modelling of 10 degrees Celsius and 80% relative humidity is not referred to in the Vipac reports. It is stated in the Vipac report that the ISO 9613 results were used because they were higher than the CONCAWE results. This needs to be demonstrated with the use of appropriate conditions set in the SA guidelines for the CONCAWE noise model, rather than using alternative ground absorption values. The title for table 6.2 in Appendix G2 could be misleading since ISO 9613 does not include wind speed or direction so the reference to wind speed only relates to the sound power from the wind generator and 'Meteorological Conditions G=0.0' is actually a value for ground absorption.

Even with the use of questionable noise modelling, there are exceedances of target noise limits that require special noise reduction operating modes for some turbines. It is still proposed that these be built and that the level of actual noise reduction needed be determined from the compliance testing. We find this approach inappropriate.

The last paragraph of section 6 Noise Model is a biased statement. The Senate enquiry report into wind farm noise acknowledges that there is no peer reviewed research to support the statements in the Vipac report about infrasound.

Section 6.2 of Appendix G2 states that the 95% accuracy of ISO 9613 is of the order of +/- 4dB(A) to +/- 5dB(A). This is contradictory to the model accuracy stated in Chapter 12 of the main report which uses +/- 2dB(A) as described earlier in this review. The fourth bullet point in section 6.2 of Appendix G2 can be used equally to justify higher noise levels than modelled and does not represent a conservative approach. No account has been made for the turbulence effects from upwind turbines that can increase noise emissions above those used for the modelling. It would be better to use CONCAWE as recommended by the SA guideline with the recommended input parameters. At least the CONCAWE model can account for higher wind speeds using Category 6.

The 'Noise sub plan' of the OEMP refers to situations in the event of non-compliance with noise limits derived in accordance with the SA guidelines. The compliance checks are to be conducted at the closest relevant receiver residences but these are not identified. The words allow for just two residences to be measured as a minimum. The text goes on to say that if complaints arise from 'more distant receivers' that these will be investigated. However, no compliance checks are offered for these residences. The difficulty in assessing compliance comes from the fact that background sound levels were not completed at each potentially exposed residence. Rather, only five monitoring locations have been used for all of the residences. The background surveys reported leave one to suspect the data collected and this makes any test of compliance problematic unless the surveys are repeated.

Reference is made to 'relevant residences' being those near the wind farm that do not have a financial interest through siting turbines on their property and 'non-relevant receivers' for those that have financial interests in the project. A further section of the community is called 'non-residential receivers outside the project area' which is a subset of the non-relevant receivers.

An outdoor target noise level from the wind farm for the non-relevant receivers is proposed at 45 dB(A). It is suggested that this is a sound level limit that will ensure no sleep disturbance in accordance with the World Health Organisation Community Noise Guidelines. Extracts from the WHO Guideline follow:

> ***10.4 Consideration of Vulnerable Groups***
> The evaluation of noise effects and related protective standards are virtually based on data from "normal", "average" people. They are usually adult

participants of investigations, selected as representative samples of the general population, or sometimes because of availability. However, people having less abilities and/or possibilities to cope with the impacts of noise exposure, and thus being at greater risk for harmful effects, might be underrepresented or insufficiently considered in noise protection necessities. Examples of vulnerable groups are: people with particular diseases or medical problems (e.g., high blood pressure), people in hospitals or in rehabilitation, people dealing with complex cognitive tasks, the blind, people with hearing impairment, babies and young children and elderly in general. For every noise protection guideline the issue of vulnerable subgroups of the population has to be considered. This is valid for types of effects (communication, recreation, etc.) as well as for places of exposure (home, workplace, public institutions, etc.).

10.6.3 Sleep Disturbance

Sleep disturbance due to continuous, as well as intermittent noise, has been demonstrated by electrophysiological and behavioral methods. The more intense the background noise is, the more disturbing is its effect on sleep. Measurable effects start from about 30 dB LAeq. Physiological sleep effects include changes in the pattern of sleep stages, especially a reduction in the proportion of REM-sleep. Subjective effects have also been identified such as difficulties in falling asleep, perceived sleep quality, and adverse after effects like reported headache and tiredness. The sensitive groups are believed to include mainly elderly persons, shift workers, persons who are especially vulnerable due to physical or mental disorders, and other individuals who have sleeping difficulties.

The probability that sleep will be disturbed by a particular noise depends on a number of factors including the interference criterion used (e.g., awakening or solely EEG changes), the stage of sleep, the time of night, the character of the noise exposure, and adaptation to the noise. Individual differences in sensitivity are pronounced. Although systematically collected field data on sleep disturbance are limited, there is some consensus of opinion that where noise exposure is continuous, the equivalent continuous sound pressure level indoors at night should not exceed approximately 30 dB LAeq if negative effects on sleep are to be avoided.

Low frequency noise, for example, from ventilation systems, can disturb rest and sleep even at low intensity. In the presence of a large proportion of low frequency sounds a still lower value than 30 dB LAeq would be needed. It should be noted that the adverse effect on sleep partly depends on the nature of the noise source.

Sleep disturbance increases with increased maximum sound pressure level. Even if the total equivalent continuous sound pressure level is fairly low, a small number of noise events with a high maximum level will affect sleep adversely. Therefore, guidelines for community noise to avoid sleep disturbance should be expressed not only in terms of equivalent sound pressure level but as maximum levels, and number of noise events during night, as well.

If the noise exposure is not continuous, the maximum sound pressure

> level is best correlated to sleep disturbances. Effects have been observed at individual exposures of 45 dB LAmax, or even less. It is especially important to limit the noise events exceeding 45 dB LAmax especially where the background sound pressure level is low; in fact, to protect sensitive persons a still lower guideline value would be preferred.
> Measures reducing disturbance during the first part of the night can be predicted to be most cost effective. In the first place, efforts should be made to reduce the sound pressure level of noise maxima and the number of noise events before focusing on reducing the equivalent level.
> Sleep disturbance is the critical effect in bedrooms, in dwellings and preschools. Recommended guideline values inside bedrooms are 30 dB LAeq for steady-state continuous noise, and for a noise event 45 dB LAmax, preferably even lower, about 40 dB LAmax. Lower sound pressure levels may be annoying depending on the nature of the noise source. The maximum level should be measured with the instrument set at ”fast”.
> At nighttime outdoors, sound pressure levels should not exceed 45 dB LAeq, so that people may sleep with bedroom windows open. This value has been obtained by assuming that the reduction from outside to inside with the window open is 15 dB; note that the actual reduction may be less in some cases, maybe only 5-7 dB, which then would mean that the sound pressure level outdoors needs to be kept at or below 35-37 dB LAeq.
>
> ***10.7 Summary***
> **…..**Inside bedrooms the sound pressure level should not exceed 30 dB LAeq for steady-state continuous noise, and for a noise event not exceed 45 dB LAmax, preferably even lower (maybe 40 dB LAmax). Still lower levels may be annoying depending on the nature of the noise source. At nighttime, sound pressure levels outdoors should not exceed 45 dB LAeq, so that people may sleep with bedroom windows open. Even lower levels may be required pending the design of the window opening, maybe 35-37 dB LAeq outdoors.

It is important to note that the use of a 45 dB(A) target outside noise level will not be adequate to protect sleep if the attenuation of sound from outside a home to inside a bedroom is less than 15 dB(A). From measurements we have completed recently, the best attenuation achieved for bedrooms with open windows in three different typical Australian weather board properties on farms was at most 5 dB(A) and was more typically 3 dB(A).

It is doubtful if the seven ‘wind-farmers’ or non-relevant receivers that are located within 1 km of the turbines know or understand what sound levels they will be exposed to at night in the summer months with windows open. The internal sound levels predicted will not protect sleep if the attenuation of sound from outdoors to a bedroom is only 3 dB(A) with windows open.